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# Integrated Pump Assembly - An Active Cooling System for Mars Pathfinder Thermal Control

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## ABSTRACT

An important element of the Mars Pathfinder thermal control system is the integrated Pump Assembly (IPA). As a part of the Heat Rejection System (HRS) of the spacecraft, the IPA circulates and controls the working fluid in the HRS in order to transfer excess heat from the various spacecraft parts to the radiator. The IPA consists of mechanical centrifugal pumps and is the only active component of the HRS.

The Heat Rejection System of Mars Pathfinder is designed to actively control the temperatures of the various spacecraft parts. The system is designed to keep the lander and cruise stage electronics between -30 to +40 C during the entire cruise from Earth to Mars. This is achieved by circulating Freon 11 through the heat exchangers in the lander equipment shelf, cruise electronic box and dumping heat in the cruise stage radiator,

The IPA was designed to meet the HRS and the Mars Pathfinder requirements. The important Pathfinder requirements for the IPA were: 1) redundancy for the active components of the IPA since such a system has never flown in space for durations longer than a few weeks, 2) total mass of 5.8 kg including the mounting baseplate which is installed on to the spacecraft, and 3) maximum power consumption of 10 Watts. The key requirements of HRS were Freon operating pressures, flow rates, pressure drops, radiator bypass flow rates, and the leakage rates.

The major elements of the IPA are: two centrifugal pumps, an accumulator, two thermal control valves, four check valves, and the motor control electronics. All these elements are mounted on a base plate which is bolted to the spacecraft cruise stage. Only one pump/thermal control valve is needed to circulate the Freon 11, the working fluid, in the system. The other pump/thermal control valve acts as a backup. The pump is rated to produce 6 psid at a rated flow of 0.2 gpm of Freon 11 in the -30 to +30 C range. The motor control electronics are designed to operate the pump motor at the rated performance over an input power of 27 to 36 Vdc. The maximum operating pressure of the system is 95 psia. The accumulator keeps the operating pressure 30 psig above the saturation pressure of Freon at the operating temperature.

The IPA has an all welded stainless steel construction bolted to an aluminum base plate. All the electronics are housed in an aluminum box mounted to the pump/accumulator housing of the IPA. The IPA has an inlet port, one radiator outlet and one bypass outlet port, one liquid and one gas fill port, one purge port, and three vent ports. A pressure transducer is used to monitor the gas side pressure of the accumulator.

Two life test pump/motor units were fabricated before the flight IPA was built. The life test units were tested to verify the design and life of the pumps. A few design changes were made in the IPA design based on the life test unit experience.

At present, the IPA is being assembled and will be welded and acceptance tested by 1 December 1995. The acceptance tests include performance tests, sinusoidal and random vibration tests, protoflight thermal vacuum test, and the EMC tests. Two IPA assemblies are planned to be built by the end of December 1995. The first unit will be installed on the spacecraft by the middle of December 1995. The results from the acceptance tests and the spacecraft system level tests will be reported in the paper at the July 1996 ICES conference.